FEDERAL COMMUNICATIONS COMMISSION
INTERNATIONAL BUREAU

Satellite and Radiocommunication Division
Satellite Policy Branch

To: Mr. William F. Caton, Acting Secretary

Date: February 6, 1996

From: Jennifer M. Gilsenan

Re: Ex Parte presentation
CC Docket No. 92-297

This will serve to indicate that on February 5, 1996 representatives of the International Bureau, the Office of Plans and Policy and the Wireless Telecommunications Bureau met with participants listed in Attachment A to this memorandum to discuss the Commission's proposals in the above-referenced proceeding.

The attached documents formed a basis for discussion.

Attachment A

February 5, 1996

NAME	ORGANIZATION	PHONE	FAX
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Richard Barnett	TS for Lockheed Martin	301-229-0204	301-320-2421
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Philip Rubin	PanAmSat	202 296 9380	202 2969383
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Tren Griffin	Teledesic Corp	206 803 1400	206 803 1409
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BERNARD VEGREL	HCI	310-607-4595	310-607-4445
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Bob Almond	BellSouth	202 463 4112	202 463 4198
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Paul MISENER	WRTF/TEXAS INSTRUMENTS	202-828-7506	202-429-7049
BOB PETTIT	WRTF/T.I.	202-429-7019	202-429-7049
Wayne Longman	Teledesic	202-[illegible]3425	202-296 8953
Julian L. Shepard	Verner Liipfert et al for Orion	202-371-6111	202-371-6279
Peter Hadinger	TRW	703 276-5156	703-276-5029
Greg Rosston	Deputy Chief Economist FCC	202 418-2044	202 418-2807
Susan Magnotti	FCC	202.418.0871	202-418-2643

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BAND PLAN OPTIONS

February 5, 1996

BAND PLAN PREFERENCES

HUGHES COMMUNICATIONS

1 GHz GSO/FSS spectrum is essential

- Supports mass market access
- Ubiquitous, low cost terminals
- Only 62% of international GSO FSS allocation

Objective is 1 GHz "clear" spectrum

- Already sharing with 2 degree adjacent GSOs
  - typical impact is 5-15% loss of capacity
  - e.g., Galaxy IV lost 7% of Ku capacity after extensive coordination
- Willing to accept 1 GHz spectrum shared with NGSO MSS with certain constraints

OPTION 3 NOT ACCEPTABLE

HUGHES COMMUNICATIONS

Inadequate bandwidth significantly hinders mass market business cases

- 12 % reduction for GSO/FSS
- 17 % reduction for NGSO/MSS feeder links

Penalizes efficient GSO/FSS multibeam architecture

Requires reworking of GSO/FSS system

- Schedule delay
  - Increased cost
- Lost capacity
  - Smaller market
- Missed market opportunities

Incompatible with WRC-95 and US position on GSO/NGSO sharing

GSO/NGSO SHARING IS POSSIBLE WITH CERTAIN CONSTRAINTS

HUGHES COMMUNICATIONS

- **Both Options 1 & 2 share GSO/FSS with NGSO/MSS feeder links**
- **Hughes and TRW have worked to share spectrum for over a year**
- **Sharing is feasible according to principles agreed upon by Hughes and TRW**
  - Other GSO/FSS systems have similar capability
- **Sharing imposes constraints on both GSO and NGSO**
  - Requires separation of Iridium 150 MHz and shared GSO/NGSO
  - Requires downlink band separation
  - Constrains NGSO feeder link site selection
  - Adversely affects GSO performance in several ways
    - e.g., link availability, capacity in shared beams

Option 2 A

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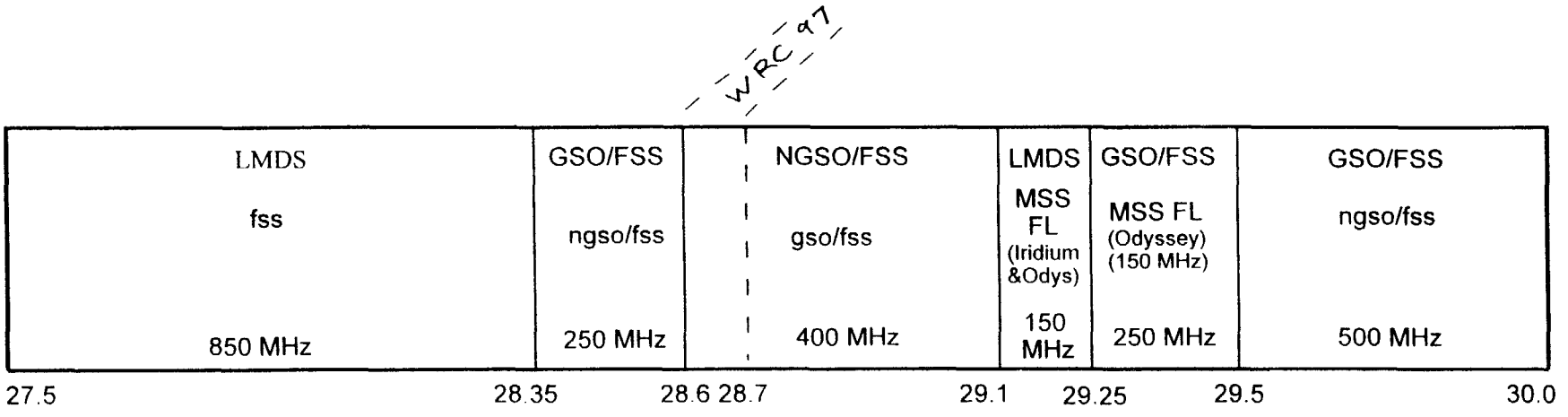

- **TRW/Odyssey and GSOs share 150 MHz without Iridium in same band**
- **TRW/Odyssey share 150MHz with Iridium**
- **Iridium and LMDS share 150 MHz**
- **Teledesic has conditional 400MHz without need to share and potential additional 100MHz allocated at WRC '97**
- **All get BW needed but LMDS must share with Iridium**

Option 2 B

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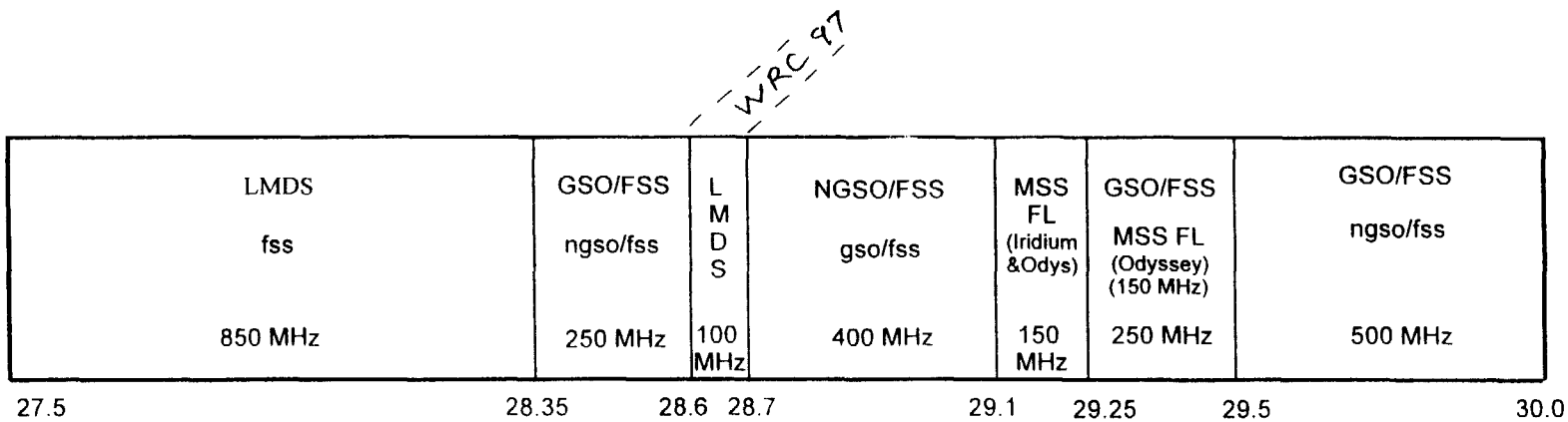
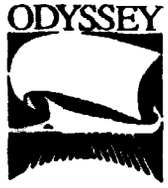


- LMDS return links moved to 28.6 to 28.7 GHz
- LMDS sharing with NGSO FSS (Iridium) avoided
- Teledesic BW constrained to 400 MHz - WRC '95 conditional allocation
- LMDS has 25 MHz less BW than option 3 – but clear
- All others stay the same – reduces sharing requirements on Iridium and Odyssey



TRW

CO-DIRECTIONAL FREQUENCY SHARING BETWEEN ODYSSEY™ FEEDER LINKS AND GSO/FSS SERVICE LINKS IN 29.25-29.5 GHZ AND 19.45-19.7 GHZ BANDS

M. Horstein
R. Rusch

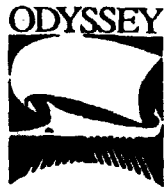
February 5, 1996

Sharing Criteria

- **Acceptable interference due to NGSO/MSS feeder link at demodulator input in GSO/FSS system (CPM Report 95/118), based on interference/ thermal noise spectral density ratio (I_o/N_o)**

Interference Level, I_o	Percent of Time Exceeded
Negligible (≤0.06)	0.87
0.78No	0.119
2.98No	0.0294
14.8No	0.0004

- **The same criteria will be assumed for FSS/GSO interference into NGSO/MSS feeder links**

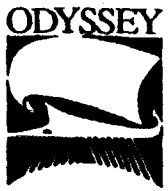


General Coordination Requirements

TRW

- The two interference mechanisms that can create a need for coordination are interference
  - From GSO/FSS earth terminals into Odyssey™ satellites
  - From Odyssey™ satellites into GSO earth terminals
- The need for coordination arises only for geometries in which an Odyssey™ earth station off-axis angle (i.e., the angle between lines of sight to an Odyssey™ satellite and a GSO/FSS satellite) is
  - Less than 1.0° for 0.66m GSO/FSS terminals, or
  - Less than 0.5° for 1.8m GSO/FSS terminals,

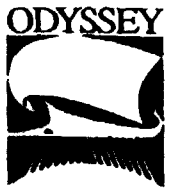
  and only if the elevation angle from the Odyssey earth station to the GSO/FSS satellite exceeds 30°
- When required, coordination applies only to GSO/FSS terminals located within a specified coordination area about the Odyssey™ earth station
- On a global basis, approximately 40% of the geostationary band requires no coordination with respect to any of the eight candidate Odyssey™ earth station locations



Coordination Requirements for GSO/FSS Satellites Providing U. S. Service

TRW

- 13 applied-for GSO slots from six different systems were examined to determine coordination requirements
- Based on an off-axis-angle criterion of 1° and an assumed satellite phasing, Odyssey™ candidate U. S. earth stations have the following coordination requirements:
  - 3 of 13 GSO slots for San Luis Obispo, CA
  - 5 of 13 GSO slots for Portland, ME
- There is generally one "encounter" daily between each GSO satellite/ Odyssey™ earth station pair requiring coordination
- For a required off-axis angle of 1°, each encounter lasts for 25 to 110 seconds, depending on the degree of "in-line" coincidence

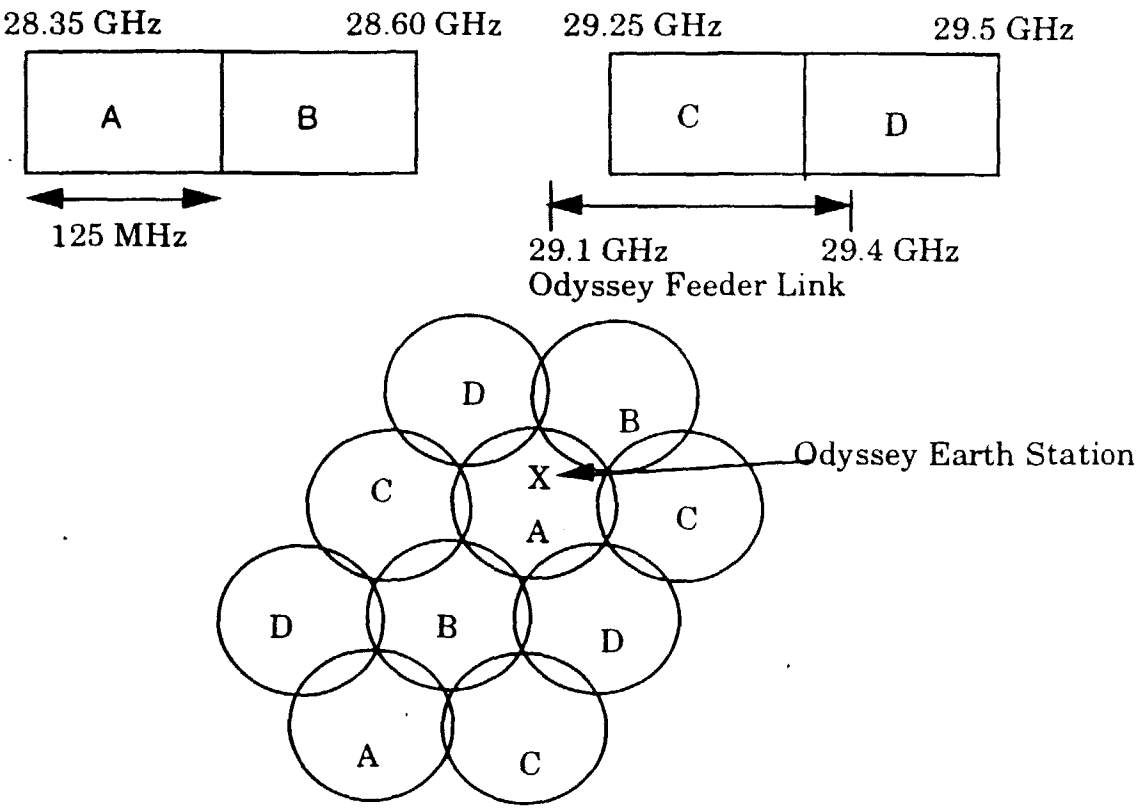


Approach to Spectrum Sharing

TRW

- Spectrum sharing between Odyssey™ and GSO/FSS systems is predicated on
  - Single polarization of Odyssey™ transmissions
  - Frequency reuse plans (including both polarizations) of GSO/FSS systems
- Coordination can take the form of GSO/FSS system choosing disjoint frequency band or opposite polarization from Odyssey™ in beam(s) overlapping coordination zone
- Coordination can be aided by
  - Modification to Odyssey™ satellite phasing
  - Slight shift in GSO/FSS satellite antenna footprint
- It is anticipated that coordination as described above will preclude the need for Odyssey™ or GSO/FSS systems to interrupt transmissions

Co-Polarization Frequency Plan to Avoid Interference



Spectrum Sharing Principles Adopted by TRW and Hughes

TRW

- Sharing principles apply to the 29.25-29.4 GHz band and, following WRC-97, also to the 29.4-29.5 GHz band
- The party causing unacceptable interference has primary responsibility to mitigate the interference, but neither system shall be required to disrupt or alter its transmissions.
- Once Odyssey™ earth station locations and the frequency/polarity of its feeder link transmissions are defined, GSO/FSS operators will implement beam frequency selection and/or opposite sense of polarization in the vicinity of Odyssey™ earth station complexes in order to minimize instances of unacceptable interference in a manner that is consistent with their GSO beam footprint.
- Only NGSO/MSS systems may use the 19.3-19.7 GHz band as a companion downink band to the 29.1-29.5 GHz uplink band. GSO/FSS systems may use any part of the 17.7-18.55 GHz band as a companion downlink band to the 29.25-29.5 GHz band.
- This sharing arrangement is only applicable to GSO/FSS operators and one type of NGSO/MSS system (namely, Odyssey™). An additional NGSO/MSS system will be accommodated only subject to further sharing and coordination agrements that are acceptable to the affected parties. Nevertheless, the sharing principles identified herein can be considered in attempting to reach such an accommodation.

Uplink Interference at Ka-Band from MSS Feeder Links (Iridium) into GSO FSS Systems

Dr. Richard Barnett

TELECOMM STRATEGIES for Lockheed Martin

February 5, 1996

Assumptions (1)

- Worst case:
  - co-frequency (full frequency overlap)
  - co-polar (both operating in same polarization)
  - co-coverage (GSO receive beam peak at Iridium earth station)
- I_0/N_0 criteria:
  - CPM Report 95/118 (although not an ITU-R Rec.)
- Interferer as defined by Iridium:
  - transmit power density (peak) = -54.4 dBW/Hz
  - transmit earth station gain (peak) = +56.3 dBi
  - off-axis gain envelope < 29-26 log(theta) dBi

Assumptions (2)

- GSO satellite receive characteristics:
  - peak antenna gain = 43.4 dBi (approximately 1° diameter)
  - system noise temperature = 600K (i.e., +27.8 dB-K)
  - gives G/T = +15.6 dB/K
- Above beam is compatible with the use of 65 cm user terminals
- Receive antenna beam peak pointing towards Iridium uplink earth station location

In-Line Interference Analysis

	IRIDIUM	ODYSSEY
Interfering power density into uplink antenna	-54.4 dBW/Hz	-55.49 dBW/Hz
Peak gain of uplink antenna	+56.3 dBi	+64.8 dBi
Peak interfering EIRP spectral density	+1.9 dBW/Hz	+9.31 dBW/Hz
Space loss	-213.5 dB	-213.5 dB
GSO satellite peak gain	+43.4 dB	+43.4 dB
GSO received interfering power density (I_0)	-168.2 dBW/Hz	-160.79 dBW/Hz
GSO satellite noise temperature	+27.8 dBK (600K)	+27.8 dBK (600K)
Boltzmann's constant	-228.6 dB	-228.6 dB
GSO receive noise power density (N_0)	-200.8 dBW/Hz	-200.8 dBW/Hz
GSO receive I_0/N_0	+32.6 dB	+40.01 dB

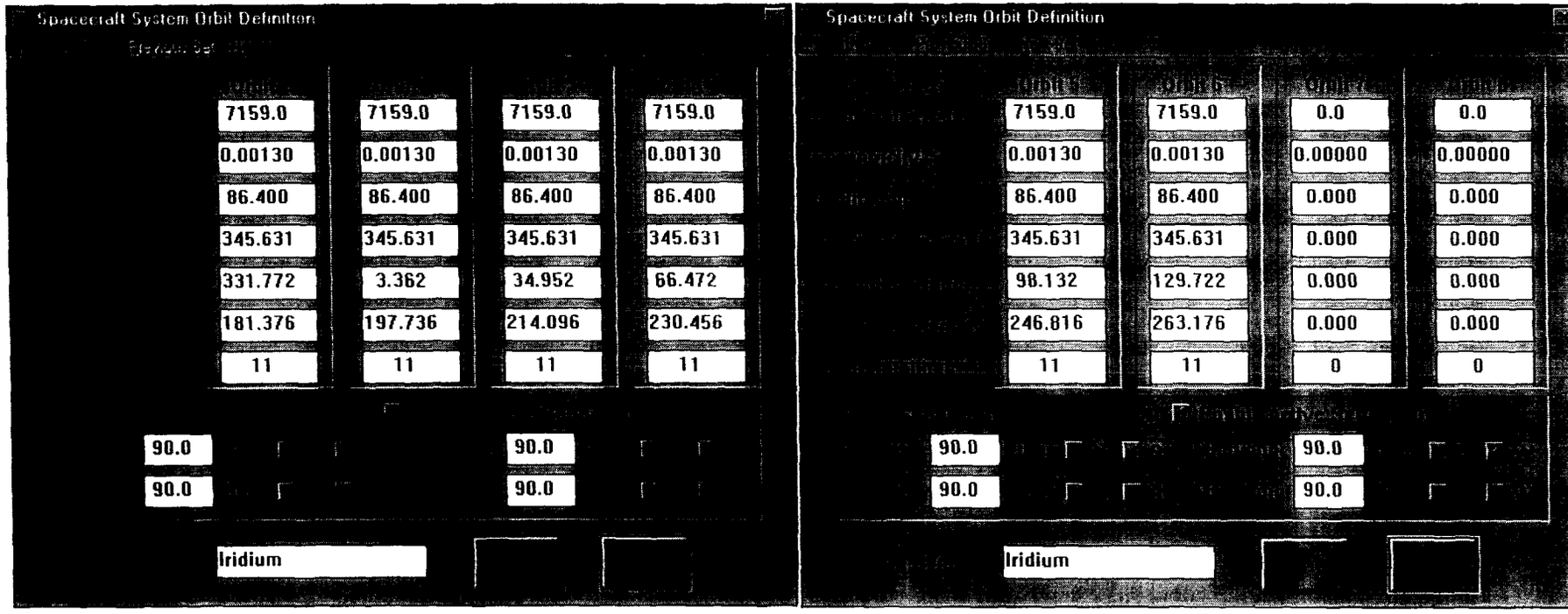
Interference Threshold Off-Axis Angle

CPM criteria (95/118)			Computed isolation requirements for interference threshold			
			IRIDIUM		ODYSSEY	
% time not to be exceeded	I_0/N_0 (linear)	I_0/N_0 (dB)	Off-axis isolation	Off-axis angle 29-26log(θ)	Off-axis isolation	Off-axis angle 29-25log(θ)
0.87	0.06	-12.22	44.82 dB	4.72°	52.23 dB	4.54°
0.119	0.78	-1.08	33.68 dB	1.76°	41.09 dB	1.63°
0.0294	2.98	+4.74	27.86 dB	1.05°	35.27 dB	0.95°
0.0004	14.8	+11.70	20.90 dB	0.57°	28.31 dB	0.50°

Iridium Simulation

- Assume feeder link earth station tracks all visible Iridium satellites (not just highest elevation satellite).
- Statistical results for each Iridium feeder link earth station site in the GSO/FSS coverage area may need to be summed to compute aggregate uplink interference.
- 30 day simulation takes <10 minutes computation time. (results stable after less than 10 days simulation).

Iridium Constellation Definition



Simulation Results ($I_0/N_0 = 0.06$)